JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 20 OCTOBER 19, 1930 No. 17

GEOLOGY.—*Paleozoic formations in the Gold Hill quadrangle, Utah.*[1] THOMAS B. NOLAN, U. S. Geological Survey. (Communicated by R. C. WELLS.)

Within the Gold Hill Quadrangle in western Utah, there is exposed a section of Paleozoic rocks that is comparable in thickness and in the time intervals represented to that at Eureka, Nevada.[2] The situation of the quadrangle (just east of the Nevada-Utah line and at the 40th parallel) about midway between the classic Nevada section and the well-known sections in the Wasatch[3] and in the Tintic district[4] makes this stratigraphic column of particular interest. In the present paper the Paleozoic formations that have been distinguished in the quadrangle are named and very briefly described, in advance of a more extended discussion which is to be published by the Geological Survey.[5] Table 1 summarizes the section.

CAMBRIAN SYSTEM

Prospect Mountain quartzite.—The oldest formation exposed is a massively bedded quartzite that is identified with the Prospect

[1] Published by permission of the Director, U. S. Geological Survey. Received July 3, 1930.

[2] Arnold Hague. *Geology of the Eureka district, Nevada.* U. S. Geol. Survey Monograph **20.** 1892.

[3] F. F. Hintze. *A contribution to the geology of the Wasatch Mountains, Utah.* Annals New York Acad. Sci. **23**: *85–143.* 1913. F. C. Calkins. In *Ore deposits of Utah.* U. S. Geol Survey Prof. Paper **111**: *233–239.* 1920.

[4] G. F. Loughlin. *Geology and ore deposits of Tintic mining district, Utah.* U. S. Geol. Survey Prof. Paper **107.** 1919.

[5] *Geology and ore deposits of the Gold Hill quadrangle, Utah.* U. S. Geol. Survey. (Report in preparation.)

Mountain quartzite of the Eureka district.[6] There are several thin shale beds in the upper part of the formation and lenticular conglomerates are rather abundant. Near the base of the formation as exposed in the quadrangle, there are several horizons of dark micaceous shale and some thin beds of dark quartzite that are interbedded with the normal quartzite. These shale horizons are well exposed along Basin Creek on the east front of the Deep Creek Mountains, 7 miles south of the southern boundary of the quadrangle.

The formation at this locality was estimated to be about 4,750 feet thick, divided as follows: (1) at top, quartzite, 2500 feet; (2) shale, 300 feet; (3) quartzite, 500 feet; (4) shale, 600 feet; (5) quartzite, 200 feet; (6) shale, 100 feet; (7) quartzite, 500 feet; (8) shale, 50 feet. No fossils were found in the formation, but, since it underlies conformably a Lower Cambrian formation, it is thought to be of the same age.

Cabin shale.—This formation, named from exposures in Cabin Gulch, south of North Pass Canyon, is composed dominantly of a dark green or khaki colored shale, which is only locally calcareous. Sandy laminae are abundant near the top of the formation, which grades, rather abruptly into the overlying Busby quartzite. The average of two fairly satisfactory measurements gave a thickness of 510 feet. A single fragmentary trilobite, found by Dr. Edwin Kirk, Jr., was submitted by Dr. C. E. Resser who reports that "the thoracic segment from Sheep Canyon, because of the sharp angle on its anterior side, seems pretty definitely to belong to a Mesonacid which would make it Lower Cambrian in the present usage of that term in the West."

Busby quartzite.—The basal 50 to 75 feet of the formation here named Busby quartzite is made of coarse-grained quartzite which contains in places tiny rock fragments in addition to quartz. Thin beds of dark quartzite and green sandy shale in varying proportions compose the remainder of the formation, the shales becoming increasingly abundant upwards. Mud cracks and fucoid markings are present in many of these beds. The top of the formation has been arbitrarily placed at the base of the lowest limestone bed, although quartzites and shales similar to those in the Busby are present above this line. The average of two closely accordant measurements indicates that the thickness of the formation is not far from 440 feet. No fossils have been identified from the formation but the gradational character of the contact with the overlying Abercrombie formation of

[6] Arnold Hague. *Abstract of the report on the geology of the Eureka district, Nevada.* U. S. Geol. Survey Third Ann. Rept. 254. 1882.

Middle Cambrian age make it appear that the Busby quartzite is also of this age. The formation name is taken from Busby Canyon, on the northeast slope of Dutch Mountain, in which this formation is exposed.

Abercrombie formation.—The most characteristic type of lithology in the formation here named Abercrombie formation is a blue-gray dense limestone whose thin bedding is caused by thin bands or partings of

TABLE 1.—PALEOZOIC FORMATIONS IN THE GOLD HILL QUADRANGLE, UTAH

System	Series	Formation	Thickness in feet
Carboniferous	Permian	Gerster formation	600
	Permian and Pennsylvanian	Oquirrh formation	8000±
	Pennsylvanian (Pottsville) and Mississippian (?)	Manning Canyon formation	500±
	Mississippian (upper)	Ochre Mountain limestone	4500±
		Woodman formation	1500±
	Mississippian (lower)	Madison limestone	0–400
Devonian	Middle	Guilmette formation	900–1200
		Simonson dolomite	1000
		Sevy dolomite	450
Silurian		Laketown dolomite	1000±
Ordovician	Upper	Fish Haven dolomite	250
	Lower	Chokecherry dolomite	0–1000±
Cambrian	Upper	Hicks formation	600–1200
		Lamb dolomite	1050
	Middle	Trippe limestone	725
		Young Peak dolomite	0–600
		Abercrombie formation	2700
		Busby quartzite	450
	Lower	Cabin shale	510
		Prospect Mountain quartzite	3000–4750±

shale, which may be yellow, buff, pink or light gray. The limestone bands are from one-quarter to one-half inch thick. The shaly material is present only locally along many of the bedding planes and similar splotches of shale are found less commonly within the limestone and not parallel to the bedding. With increase or decrease in the amount of shale, the rock grades into lenticular shale beds or into relatively massively bedded limestones. Where best exposed the formation is

approximately 2700 feet thick. Almost all of the shale beds are fossiliferous. Dr. C. E. Resser of the National Museum divided the collections made into two groups. One of these, from the lower portion of the formation, contained *Bathyuriscus productus*, *Zacanthoides* sp, *Obolus* sp, *Linguella* sp, and *Hyolithes* sp. He writes: "This seems to be the lowest horizon secured. The fauna corresponds with the Chisholm and Ophir." From the other group, *Elrathia* sp, *Paterina cf. utahensis*, *Micromitra* sp, *Obolus* sp, and Fucoids were recognized. This group he considers as Middle Cambrian, somewhere in the lower part. Abercrombie Peak on the ridge south of Dry Canyon is underlain by the formation.

Young Peak dolomite.—At the southern end of the quadrangle the formation here designated as Young Peak dolomite consists of 600 feet of massive dark gray to black crystalline dolomite spangled with short white rods of dolomite. Hand specimens of the rock are identical with those from the Bluebird dolomite at Tintic.[7] As the formation is followed to the north, however, the dolomite interfingers with shaly limestones similar to those in the Abercrombie formation. Less than 5 miles to the north only a few feet of dolomite can be found, and the stratigraphic interval of the formation is occupied by portions of the Abercrombie formation. The upper contact of the formation is remarkably persistent in view of the characteristic lenticular habit of most of the Cambrian formations. This horizon, which marks the base of the overlying Trippe limestone, consists of a dark gray dolomite containing abundant nodules of dark gray chert which may reach several feet in diameter. It is overlain by a cream colored, finely laminated dolomite. These beds extend beyond the last reminants characteristic of the Young Peak dolomite. No determinable fossils were found in the dolomite, but it is undoubtedly of Middle Cambrian age. The dolomite is well exposed on Young Peak on the south side of Dry Canyon.

Trippe limestone.—This formation, named from exposures in Trippe Gulch on the south side of North Pass Canyon, is composed in large part of thin-bedded shale-mottled limestones similar to those that are so abundant in the Abercrombie formation. It contains in addition a few dark dolomite layers, beds of more massive limestone, and several horizons of finely laminated white dolomite and limestone. Most of the beds appear to be lenticular, since sections of the formation

[7] G. F. Loughlin. *Geology and ore deposits of Tintic mining district, Utah.* U. S. Geol. Survey Prof. Paper 107: 28. 1919.

at different points fail to show similar sequences and thicknesses. The average of three measurements of the Trippe limestone is 725 feet. No fossils were found in any of these beds but the fact that much of it is lithologically similar to the Abercrombie formation makes it seem probable that it too is of Middle Cambrian age.

Lamb dolomite.—The lower third of the formation, here named Lamb dolomite is made up largely of thick-bedded oolitic and pisolitic dolomites, some of which are cross-bedded. Above this lies thick-bedded medium gray dolomite that is mottled by patches of dolomite containing white rods and resembles closely parts of the Young Peak dolomite. In the upper 150 feet thinner bedded dolomites with sandy partings become increasingly abundant and these grade upwards into a sandstone weathering reddish-brown that was chosen to mark the upper limit of the formation. This sandstone lenses out to the north but a similar lens starts at about the same locality a short distance higher stratigraphically. The Lamb dolomite is 1050 feet thick. Although no fossils were collected from it, its age is thought to be Upper Cambrian, since it is similar lithologically to the overlying Hicks dolomite, which is definitely of this age. The formation is exposed in Lamb Gulch, on the north side of Dry Canyon.

Hicks formation.—The greater part of the beds here named Hicks formation consist of dolomites similar to those in the Lamb dolomite, but the formation also contains lenticular beds of sandstone, fossiliferous limestone, and, in one place, shale. Two collections of fossils from one of the limestones were reported by Doctor Resser to contain *Pseudagnostus* sp., *Dunderbergia* sp., *Obolus* sp., and *Acrotreta* sp. He reports that these represent a lower Upper Cambrian horizon. The thickness of the formation varies from 1200 feet to less than 600 feet, the more southern sections being the thinner. This decrease in thickness is found within a strike distance of 3½ miles and is thought to indicate an erosional unconformity between the Hicks formation and the overlying Chokecherry dolomite, of Lower Ordovician age. The same is taken from Hicks Gulch in North Pass Canyon, in which the formation is well exposed.

ORDOVICIAN SYSTEM

Chokecherry dolomite.—This formation is characterized by the presence of considerable silica, found both as nodules and bands of chert, usually dark gray to black in color, and as sandy laminae between thin beds of dolomite. The lower beds are, as a rule, rather massively

bedded chert-bearing dark-mottled dolomite, locally oolitic and cross-bedded, and containing thin lenses of dolomite conglomerate. These beds are supplanted higher in the formation by thinner-bedded dolomite with sandy laminae, or, locally, by bands of dark chert. A single collection of fossils from near the top of the formation contained only *Scaevogyra* (?) sp. Dr. Edwin Kirk, Jr., who identified it, reports: "The few gastropods in this lot do not permit exact age determination, and as yet we know of no other horizon with which it may be correlated. It may safely be considered as early Lower Ordovician, however." The formation is exposed only in the southern third of the quadrangle where its thickness ranges from 850 feet to more than 1,000 feet. In the northern part of the area it is entirely absent,—the overlying Fish Haven dolomite resting directly upon Upper Cambrian beds. There must, therefore, be a pronounced unconformity above the formation. The formation takes its name from the exposures in Chokecherry Canyon just south of the southern boundary of the quadrangle.

Fish Haven dolomite.—This formation contains the same fauna, of Upper Ordovician age, as the typical Fish Haven dolomite of northeastern Utah,[8] and has therefore been given the same name. It is composed of medium to thick-bedded dolomite, usually dark gray in color, and with but little chert. In general the mottling and other textures found so abundantly in the formations above and below are lacking. In the northern part of the area, the basal bed is full of small silicified brachiopods (*Rhynchotrema argenturbica*) and is very readily recognized. The formation preserves a remarkably constant thickness of about 250 feet throughout the quadrangle, although its contact with the overlying Silurian Laketown dolomite is wavy in detail. The following species were recognized by Doctor Kirk in the fossil collections from the formation: *Halysites gracilis, Streptelasma trilobatum, Streptelasma* sp., *Columnaria* sp., *Calapoecia* cf. *anticostiensis, Rhyncotrema capax, Rhyncotrema argenturbica, Dinorthes subquadrata, Zygospira recurvirostris.*

SILURIAN SYSTEM

Laketown dolomite.—The lower half of the formation is dark gray and rather massively bedded. Many beds are mottled or laminatedy and intraformational conglomerates are numerous. This zone is locally very fossiliferous, one bed about 100 feet above the base being

[8] G. B. Richardson. *The Paleozoic section in northern Utah.* Am. Jour. Sci. (4) 36: 409–410. 1913.

full of the pentameroid brachipod *Virgiana* sp. Above the dark dolomite is 350 to 400 feet of medium-gray, massively bedded dolomite. This horizon is almost lacking in fossils and has none of the textural features so abundant in the lower beds. It is succeeded by 150 to 200 feet of dark gray to black dolomite containing large numbers of silicified fossils, particularly corals. At the top is locally found a medium to light gray coarsely crystalline dolomite, which is sparingly fossiliferous. The upper contact of the formation is an unconformity, the overlying Sevy dolomite containing scattered boulders of the Laketown dolomite in its basal beds, and in several places, occupying depressions in the older rock. The only complete section of the formation measured 970 feet, but its thickness is obviously variable, since different horizons have been found at the contact with the overlying Devonian formation. Edwin Kirk, Jr., has examined a number of fossil collections from the beds herein identified as the Laketown dolomite, and reports that "This formation may be considered of Niagaran age. It correlates in part with the Fuselman limestone of Texas and New Mexico, the Laketown dolomite of northern Utah, and probably the upper portion of the Lone Mountain limestone of the Eureka district, Nev."

DEVONIAN SYSTEM

Sevy dolomite.—The Sevy dolomite, well exposed in Sevy Canyon on the western side of the Deep Creek Range, is remarkably homogeneous in its character throughout the area of outcrop. The typical rock is a well bedded, light mouse-gray dolomite in layers 6 to 12 inches thick, which weathers to a very light gray color. It is extremely dense and shows, on breaking, a conchoidal fracture. Most of the beds show a faint lamination parallel to the bedding. The formation contains a few beds of darker dolomite near the top and locally beds containing tiny nodules of light-colored chert. The basal bed of the formation is conglomeratic, as noted above. The only fossils found in the Sevy dolomite, which is about 450 feet thick, were a few crinoid stems and some poorly preserved gastropods, neither of which, according to Edwin Kirk, Jr., were in any way diagnostic. The formation is, however, gradational into the overlying Middle Devonian Simonson dolomite, and is presumably of the same age.

Simonson dolomite.—The characteristic rock of this formation is a dark to medium gray dolomite in which the individual grains are sufficiently large to be distinguished by the unaided eye. Individual beds are from 1 to 2 feet thick. The most striking feature of these

dolomites is the general presence of a fine lamination which is commonly extremely irregular in detail. Two non-persistent dolomite conglomerates are found within the formation and a third, which persists throughout the outcrop of the formation has been chosen to mark the upper boundary. The fossil evidence available, however, indicates that the time break represented is unimportant. The average of two measurements of the thickness of the formation is very close to 1,000 feet. Three lots of fossils collected were examined by Doctor Kirk, and were considered by him to prove the Middle Devonian age of the formation. He recognized the following species:—*Favosites* (digitate form); *Bellerophon* sp; *Stringocephalus burtoni; Martinia* cf. *meristoides; Atrypa reticularis.*

The formation takes its name from the exposures in Simonson Canyon on the western side of the Deep Creek Range.

Guilmette formation.—This formation, named from exposures in Guilmette Gulch, is composed chiefly of dolomite but contains also a number of thick limestone beds and several lenticular sandstones. The dolomite that is most characteristic is a fine-grained rock, dark to medium gray on fresh fracture and weathering to lighter shades of gray and containing numerous vugs almost completely filled with white coarsely crystalline dolomite. Less abundant but far more striking are dark dolomites filled with fragments of tubular corals. Most of these contain a coral of small diameter (*Cladopora* sp.) but a number are filled with a larger branching variety (*Striatopara* sp.). The limestone beds differ from those lower in the section, being massively bedded, dense rocks that are light brownish gray on fresh fracture but weather to shades of bluish gray. The sandstone beds form a comparatively small part of the formation, but the brownish color they assume on weathering makes them conspicuous. Three measurements of thickness ranged from 1200 feet down to 890 feet, indicating that there is an unconformity between the Devonian and Carboniferous formations in this part of Utah. Several lots of fossils were submitted to Edwin Kirk, Jr., for identification. He identified: *Favosites* (digitate form); *Syringopora* sp.; *Stringocephalus burtoni; Atrypa reticularis; Martinia meristoides; Platyschisma* (?) cf *mccoyi; Cyclonema* (?) sp.; and *Pycinodesma* sp. He writes: "The formation probably correlates with the Nevada limestone of the Eureka district in part. The horizon by virtue of the *Stringocephalus* may accurately be placed as high as Middle Devonian."

CARBONIFEROUS SYSTEM

Rocks of this age are by far the most widespread of the Paleozoic sedimentary rocks in the quadrangle. They have been divided into six formations, three of Mississippian, one of Mississippian (?) and Pennsylvanian age, one of Pennsylvanian and Permian age, and one of Permian age. Three facies of the Carboniferous have been distinguished. These have been brought into more or less close contact with each other by two large thrust faults; originally they were probably a number of miles apart. One of the three facies is represented by rather limited outcrops of only one formation,—the Woodman,—which overlies unconformably the older Paleozoic rocks. This may be called the *eastern facies*. It underlies the lower of the two thrusts and was the most easterly of the three facies. The second facies,—termed the *central facies* in this paper,—lies between the two thrusts. Three formations, the Ochre Mountain limestone, and the Manning Canyon and Oquirrh formations, are present in this facies. The third and last facies is the *western facies*, which contains representatives of all six formations. It lies above the upper thrust. The lithologic differences between the Manning Canyon and Oquirrh formations in this facies and in the central facies are striking.

Madison limestone.—This limestone on fresh fracture is a dull dark gray but weathers to a distinctly lighter gray color. The beds are moderately thin, ranging from three inches to a foot in thickness, the bedding being marked in many places by a concentration of pink or, less commonly, yellowish clay. Small amounts of similarly colored clay are also found within individual beds in some places, and the weathered surfaces of such beds have a faint pinkish mottling. At the top of the formation there are about 10 to 15 feet of more thickly bedded limestone, which contains numerous nodules of dark chert. Above this, apparently conformable, are sandstones of the Woodman formation. This formation was found only in the western facies, in which its lower limit was a thrust fault. The maximum thickness seen was about 400 feet. Several lots of fossils were collected and submitted to G. H. Girty of the Geological Survey. He reports that "there can be little doubt of the geologic age as lower Carboniferous and the correlation as with the Madison limestone."

Woodman formation.—This formation, which underlies Woodman Peak on the south end of Dutch Mountain, consists of a lower division of diminantly calcareous sandstone and an upper one of sandy limestone. The sandstone division is roughly 200 feet thick and is gen-

erally poorly exposed. The beds are purplish or reddish brown, fine grained and contain a variable though small proportion of calcite as the cement. Thin lenses of limestone and shale are interbedded with the sandstone. The greater part of the upper division is made up of sandy limestone, which is dark gray to almost black on fresh fracture but which weathers to shades of light brown to pinkish. Nodules of dark gray to black chert are abundant and many be as large as a foot in diameter. Interbedded with the limestones and gradational into them are calcareous sandstones. A few beds of relatively pure limestone may also be found. No complete sections of this formation were found in any of the three facies, but it is probable that there is no great difference in thickness or lithology between the three. The thickest continuous section found measured 1,000 feet but the top was not exposed. The total thickness probably does not exceed 1500 feet, however. A large number of fossil collections were made from the formation and Doctor Girty, who examined them, writes that they indicate an upper Mississippian age.

Ochre Mountain limestone.—This formation takes its name from the fact that it is well exposed on Ochre Mt. It is composed almost entirely of massively bedded limestones, which are usually brownish gray on fresh fracture and weather to a light bluish gray color. Most of them are fine-grained, but there are local coarser beds. Individual beds may be as much as 10 feet in thickness and almost all are more than a foot thick. The basal few hundred feet of the formation includes beds that contain large amounts of chert, some beds being considerably more than half chert. The chert is generally light gray in color but weathers to a characteristic tan. About 1700 feet above the base of the western facies lies a thin and poorly exposed horizon of black shale interbedded with sandstone which is here named the Herat shale member from exposures near the Herat claims. No lithologic distinction could be made between the central and western facies of this formation. The thickness of the Ochre Mountain limestone was not accurately determined but it appears to be about 4500 feet. It is locally abundantly fossiliferous, and Doctor Girty reports that the fossil collections made prove that the formation, like the underlying Woodman formation, is of upper Mississippian age.

Manning Canyon formation.—Both the central and western facies of the beds here identified with the Manning Canyon shale of the Oquirrh Mountains are composed almost entirely of dark quartzites and sandy shales, and black shales. The first two are relatively more abundant in the central facies, and the latter in the western facies. Limestone

beds are found only locally. The exposed thickness of the formation is very variable, ranging from only a few feet to more than 1,000 feet, but this variation appears in part at least due to the fact that the weak shales have been the locus of considerable low-angle faulting. A number of fossils collected from the interbedded limestones are considered by Doctor Girty to indicate a Pottsville or lower Pennsylvanian age. In the Oquirrh Range, to the east Gilluly found high upper Mississippian fossils near the base of big Manning Canyon shales, and it is possible that if better exposures were present at Gold Hill, a similar fauna might also be found. The writer was not able to distinguish unconformable relations between them, however, but this may have been because of the widespread alteration and crushing at this horizon.

Oquirrh formation.—The eastern and western facies of the rocks here identified with the Oquirrh formation of the Oquirrh Mountains—are strikingly different. The central facies is made up of a number of different kinds of rocks. Each rock type is repeated over and over again throughout the section, and individual beds are generally lenticular, two features which render it impossible to subdivide the formation.

The facies is prevailingly sandy. Sandstones form about half of the section, and sandy limestones and sandy shales a large part of the remainder. Interbedded with these are numerous beds of limestone and dolomite and a few horizons of conglomerate. The western facies shows very little resemblance to the central. At the base is a moderate thickness of light-colored sandstone, above which is nearly 3,000 feet of massively bedded limestones, similar lithologically to those that make up the Ochre Mountain limestone. The remainder of the formation is composed of interbedded sandstones and dolomite with only minor amounts of limestone. The total thickness of the eastern facies is unknown as the top is nowhere exposed. At least 5300 feet of beds are shown at one locality, however. The western facies is considerably interrupted by faulting but a total thickness of about 8,000 feet must be present. The formation is abundantly fossiliferous. The lower few hundred feet of both facies contains a Pottsville fauna similar to that in the underlying Manning Canyon formation. The remainder of the Central facies and the bulk of the western facies is reported by Doctor Girty to belong to the higher Pennsylvanian. A few fossils collected from the upper part of the western facies proved to be of Permian age.

Gerster formation.—The Gerster formation, named for exposures in Gerster Gulch in the northwestern corner of the quadrangle, is made

up largely of thin bedded sandy and shaly limestones, which are brownish gray on fresh surfaces, and which weather to yellowish brown or pink. The beds are from 2 inches to a foot in thickness and generally have a concentration of sandy or shaly material along the bedding planes. Locally thin beds of sandstone may be found and in most exposures moderately thick beds of cherty limestone are also present. The formation is sharply set off from the underlying Oquirrh formation by its lithology and abundant fossil content. The thickness of the formation is approximately 600 feet in the one locality where the overlying Trissic is found. Doctor Girty reports that the fauna is that of the *Spiriferina pulchra* zone of the Permian.

PALEONTOLOGY.—*Contributions to the paleontology of Peru, IV: "Orthophragmina"* (Discocyclina) *meroensis W. Berry, n.sp.*[1] WILLARD BERRY, Ohio State University. (Communicated by JOHN B. REESIDE, JR.)

In a gritty greenish-brown calcareous sandstone at Calita Mero, Department of Piura, Peru, I have found a new species of *"Orthophragmina,"* which is here named *"O." meroensis.* This species, is associated with *O. stewarti* W. Berry, originally described from the Saman conglomerate at Calita Sal, in the same Department and about seventy miles south of Calita Mero. The Saman conglomerate is, so far as I know, the only formation in the Peruvian Tertiaries containing members of the genus *"Orthophragmina"* and I think I am safe, therefore, in saying that it is this formation which is exposed near Calita Mero. The matrix is similar to that at Calita Sal except that it contains few pebbles and many of the grains are subangular. The material was apparently laid down in shallow water, though the size of the particles and almost complete absence of pebbles suggest that the deposits at Calita Mero must have been farther from shore than at Calita Sal, or the land mass from which they were derived had been eroded so that less heavy and bulky material was being carried into the ocean at that point. In general the genus *"Orthophragmina"* lived in shallow, tropical waters which were fairly free from coarser clastic material, and the matrix of the fossils from Calita Mero is in agreement with this fact. From Calita Sal I have described also solitary corals. It would seem that in this general region during Saman conglomerate times little detrital material other than much angular quartz was being deposited.

[1] Received April 1, 1930. Work carried out under a grant from the National Research Council.

The new orbitoid may be described as follows:

"Orthophragmina" (Discocyclina) meroensis W. Berry, n. sp.

Fig. 1

Test large, very thin, slightly undulating, flanged, pronounced umbo; diameter 7.5 mm.; thickness 1.84 mm.; ratio of diameter to thickness about 4:1; fairly large central boss 3 mm. in diameter with a flange about 2.25 mm. in diameter. Surface covered with small polygonal papillae 116.9 microns in diameter at the surface. The surface diameter of the lateral chambers is 97.5 microns.

In equatorial section the nucleoconch is composed of two chambers, the initial chamber is 83 microns in diameter and is half surrounded by the second chamber; diameter of the entire nucleoconch is 501 microns; the walls of the nucleoconch are thin, being only about 16.7 microns thick. The equatorial chambers are typically orthophragminic in shape and are 50 microns in radial diameter and 23.4 microns in tangential diameter near the center; 83.5 microns in radial diameter and 33.4 microns in tangential diameter at the edge of the boss, and 100 microns in radial diameter and 33.4 microns in tangential diameter at the periphery, with walls 15.6 microns thick; these chambers are arranged mostly in circles altho some of the circles are not entire but shrink in radial diameter until they merge into the chamber walls.

In vertical section (Fig. 1) the wall between the equatorial chambers and the lateral chambers is 15.6 microns thick. Vertical diameter of the equatorial chambers at the center of the test 35.1 microns and at the edge of the boss 58.5 microns; the weakness of the flange prevents any measurements at the periphery. Vertical diameter of the lateral chambers 58.5 microns near the central part of the test; thickness of the horizontal walls 7.8 microns. There are 30 lateral chambers on the side of the equatorial chambers near the center of the test.

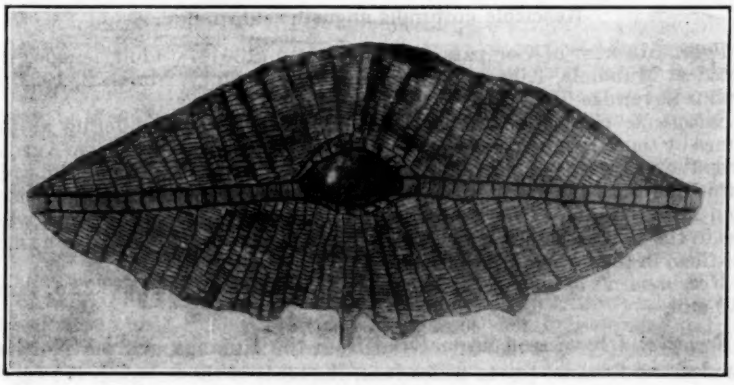

Fig. 1. Vertical section × 23

Occurrence—Calita Mero, Department of Piura, Peru, associated with *"Orthophragmina" (Asterodiscocyclina) stewarti* W. Berry.

This species is somewhat like *O. pratti* Michelin but differs in having a much bigger umbo and in having equal-size papillae. It also resembles *O. varians* Kaufmann except that the boss in *"O." meroensis* is more pronounced.

The types are deposited in the Geological Museum of the Ohio State University, Cat. No. 17114.

ORNITHOLOGY.—*The geographic variations of* Neocichla gutturalis *(Bocage)*.[1] HERBERT FRIEDMANN, National Museum.

Neocichla gutturalis (Bocage) has always been considered as an indivisible species comprising a monotypic genus. There is some uncertainty as to its correct systematic affinities. Sclater (Syst. Avium Aethiop., pt. 2, 1930, p. 359) puts it in the Timaliidae, but it may prove to be more closely allied to the starlings. The species ranges from southern Angola east through Northern Rhodesia and the Katanga to central Tanganyika Territory.

While examining two specimens of this species in the Loveridge Tanganyikan collection I took the opportunity to compare them with two birds from Angola (Boulton coll.) in the American Museum of Natural History, and found them to differ so markedly that there seemed no reason for considering them as anything but distinct subspecies. Inasmuch as the species was described from Huilla, Angola, the eastern birds are the ones that require a name. They may be known as

Neocichla gutturalis angustus subsp. nov.

Type: Museum of Comparative Zoology no. 134447, adult female, collected at Muhulala, Kilimatindi, Tanganyika Territory, March 3, 1922, by Arthur Loveridge.

Subspecific characters: Similar to the typical race but differing at first glance by the very much narrower white tips on the rectrices. In two Angolan birds the white tips of the outermost rectrices measure 12–15 mm. in width (measured along the shaft), while in five Tanganyikan specimens they measure from .5 to 5.0 mm. The nominate race is conspicuously a bird with white tips to the tail feathers; *angustus* is often practically devoid of tips or at most has them in the form of narrow bands.

Measurements of type: wing 109.0; tail 87.0; culmen from base 22.5; tarsus 28.0 mm.

Remarks: I have seen no material from the Katanga or from Northern Rhodesia and cannot say to which form the birds of those regions belong. I have seen *angustus* from the following localities (all in Tanganyika Territory); Muhulala, Kilimatindi; Kakoma; Kawewe's, 35 miles south of Tabora; and Manyani.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received August 1, 1930.

A young male topotype of *angustus*, in the plumage described by Büttikofer (Notes Leyden Museum, x, note 22, 1888, p. 229, pl. 9, fig. 1) as *kelleni*, differs from that figure in being pale buffy gray instead of bright tawny on the rump and lower back, and on the edges of the feathers of the upper back. Schalow (Journ. f. Ornith., 1883, pp. 357–358) describes a juvenal bird from Kakoma which approximates that of *kelleni*, and agrees with the present male except that he writes that the head is dark brown whereas it is black in the present example, and likewise the neck is black and white, not brown and white as in his description.

I am much obliged to the American Museum of Natural History for the loan of two Angolan and three Tanganyikan birds with which to compare the two Loveridge specimens.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

464TH MEETING

The 464th meeting was held at the Cosmos Club April 9, 1930, President G. R. MANSFIELD presiding.

Informal communication: C. P. Ross showed lantern slides of very rapid wave erosion in a Pertiary conglomerate on the shores of Gatun Lake, Canal Zone. A recession of 30 feet in 16 years has been measured. The rapidity of erosion is attributed to the susceptibility of the bentonitic matrix of the rock to attack by water.

Program: M. R. CAMPBELL: *The problem of the scientific classification of coal.*—Although coal is the standard fuel of the world, there is no generally accepted scheme of classification, either for the world as a whole or for any of the component countries. Large manufacturing organizations in the United States buy their coal generally on specifications which are based on the composition of the coal expressed in volatile matter, fixed carbon, ash or sulphur; but such a scheme is impossible of application by a small consumer, and consequently he is at the mercy of the dealer from whom he buys, who in turn is at the mercy of the jobber or the producer who mines the coal.

In order to obviate some of the difficulties specified above, a committee of the American Standards Association was organized to study the question and, if possible, propose a classification that would be generally accepted. This committee has been at work for nearly three years, devoting its time mainly to clearing the ground for real work by discarding many of the schemes already proposed as inadequate or inappropriate.

The basis for a classification has been the bone of contention and this was not cleared up until the last meeting, when it was definitely decided to base the accepted scheme of classification on the changes that vegetal matter undergoes as a result of rock metamorphism, starting with peat and ending with graphitic anthracite. The number of stages to be recognized, their names, and the criteria for their differentiation are yet to be determined. (*Author's abstract.*) Discussed by LANE.

R. W. GORANSON: *Some problems in isostasy.* (Abstract to be published in a later number of this JOURNAL.) Discussed by LOVERING.

A. C. LANE: *Geotherms.* (Abstract to be published in a later number of this JOURNAL. Discussed by HEWETT, GILLULY, G. R. MANSFIELD, SPENCER, RUBEY.

465TH MEETING

The 465th meeting was held at the Cosmos Club April 30, 1930, President G. R. MANSFIELD presiding.

Informal communications: W. D. JOHNSTON described some stalactites collected from the roof of the inspection chamber of the Wilson Dam, Muscle Shoals, Alabama. The water was completely let into the dam to a level of 90 feet above the roof of the chamber on January 1, 1925. Five years later stalactites 15 inches in length were collected. Discussed by MATTHES, THOMPSON.

Program: R. T. CHAMBERLIN: *Isostasy from a geological viewpoint.* (Abstract to be published in a later number of this JOURNAL.) Discussed by KEITH, BOWIE, LANE, G. R. MANSFIELD, SPENCER, A. C. LAWSON, HEWETT, LOVERING.

466TH MEETING

The 466th meeting was held at the Cosmos Club May 14, 1930, President G. R. MANSFIELD presiding.

Program: C. P. ROSS: *Classification of the ore deposits of south-central Idaho.*—The ore deposits of the region may be divided into two classes, of Mesozoic and Tertiary age respectively, each class divisible into four groups, each group in turn divisible into one or more sub-groups. Most of the lodes of Mesozoic age of major past and present economic importance are in shear zones and are characterized by galena and other sulphides in a sideritic gangue. They have in the past yielded moderately rich ore from shoots of good size, but attempts to follow the lodes to any considerable depth have generally been unavailing. Hopes for the future, in these lodes, lie largely in solving the problems of finding new ore shoots at greater depth and of the metallurgical treatment of the more complex ore left by the early operators. In addition, there are other deposits in shear zones characterized by jamesonite, chalcopyrite, auriferous pyrite, or other sulphides, some of which have been profitably worked on a small scale. Mesozoic irregular replacements in calcareous rocks have locally proved profitable, though individual shoots are generally small. Contact metamorphic deposits and pegmatitic veins of the same age appear to be of small economic interest.

The Tertiary lodes have been and are likely to continue to be valuable mainly for precious metals, free and in selenide, although a few good mines of copper and other base metals have been and will be developed. In the past the precious metal lodes have yielded rich ore, which, with a few notable exceptions, was in rather small bodies. Such ore is becoming increasingly hard to find, and the hope for the future lies in the development of the large, low-grade bodies of gold ore which it is impractical to mine under present conditions, partly because in many the fine state of subdivision of the precious metals, even where free, and the fact that part of the values are locked up in exceedingly fine grains of selenide, present difficult metallurgical problems. Unlike the Mesozoic deposits, some of the Tertiary contact metamorphic lodes contain commercially valuable copper, lead and zinc ore. (*Author's abstract.*) Discussed by FERGUSON, LOVERING, SPENCER, HEWETT, G. R. MANSFIELD.

F. C. SCHRADER: *Antimony deposits.*—Antimony deposits are many and widely distributed in the world. The primary and chief ore mineral is stibnite, the sulphide of antimony. It alters to various whitish or yellowish oxides, such as cervantite.

Stibnite deposits occur in various kinds of both sedimentary and igneous rocks of various ages, chiefly in limestone, shale, sandstone, and granitic rocks. They occur chiefly in quartz veins, but also as replacements and impregnations, especially along contacts and bedding planes, as in Arkansas, Bolivia, and China. They are always epigenetic or later than the rocks that inclose them, and therefore never occur as an original constituent of igneous rocks.

In a series of peripheral zones about a parent rock, antimony deposits, according to Emmons, occur in the outer zone, and with reference to depth, in the surface zone, depending on the physical and chemical conditions.

Most of the more important deposits in the United States, according to Hess, occur in and around the Great Basin in Nevada and neighboring States in a region containing largely comparatively young (Cretaceous-Tertiary) granitic intrusive and extrusive rocks in which erosion has not been sufficient to remove to great depths the rocks covering and surrounding these intrusives.

Antimony deposits are simple in character and not extensive. The average width of the lodes or veins worked is about a foot. They are pockety and usually narrow and become low grade or barren in depth, usually at depths of about 150 feet.

Commonly associated with the deposits is a small amount of other sulphides, such as pyrite and realgar, and many deposits are valuable for their gold content.

Origin.—Most stibnite deposits of commercial value for their antimony content seem to have been formed near the surface, and at not necessarily high temperatures. They were formed by ascending hot solutions, as at Sulphur Spring, Calif., and Steamboat Springs, Nev., where Becker proved that the mercury and antimony being deposited are contained in the waters as double alkaline sulphides. Stibnite and kermesite are also being deposited at the West Gore mine, Nova Scotia, and in places stibnite is being replaced by pyrite, arsenopyrite, and galena.

China.—The world's chief reserve of antimony is in China, which country in recent years has supplied 90 per cent of the world's output and is apparently able to supply the world's demand for a long time to come.

The antimony deposits in China occur mainly in the southeast provinces south of the Yangtse River in a broad northeast-southwest belt 1200 miles long. They parallel the belt, mountain ranges, valleys and rock structures of the region, which feature is regarded as favorable for their continuity. They nearly all occur in well defined veins in Paleozoic sedimentary rocks, and range in age from late Paleozoic to early Miocene.

Of the seven or more productive fields in Hunan, which is the leading province, the richest is the Hsi-K'wang Shan (Shikungshan) field which is estimated to have supplied in recent years about 90 per cent of the world's output. It is 3½ miles long by 2 miles wide. In it the deposits occur in a quartzitic sandstone of Silurian age. They occur in 4 principal groups or ranges of hills of which the richest is the Hsi-K'wang Shan,—"tin mine," or antimony,—hill. It is 1½ miles long by ½ mile wide and consists mainly of a hogback ridge in which the sandstone has been upfaulted and greatly deformed with dip about 30° SE.

The ore, which is relatively pure stibnite ore, occurs as seams, pockets, bunches, lenses and veins irregularly distributed in the sandstone, the richer ore shoots tending to occur beneath domal or anticlinal structures. The deposits have been worked to the depth of 300 feet on the incline. They constitute the largest known antimony deposit and the largest producer in

the world. The antimony content of the sandstone taken as a whole in the ridge, is estimated by Tegengren to be about 6%, and the total visible reserves of the ridge to have been about 1,500,000 tons of metallic antimony, of which only about 100,000 tons or 200,000 tons of 55% ore had been mined by 1915.

The deposits seem to have been formed by ascending thermal solutions derived from some deep-seated intrusive rock not yet found in the present field. Of the three other groups or ranges of deposits in this field, that of the Kiang Ch'ung range is estimated to be nearly as rich as the one just described.

America.—In the Americas, nearly all the antimony deposits occur on or near the Pacific slope in a relatively narrow belt extending from Bolivia 8,000 miles northwestward through South and Central America, Mexico, United States, Canada and Alaska to the Arctic Coast at Cape Prince of Wales. They are associated with the various mountain ranges en route and relatively young granitic rocks. Occurring in this belt and ranking next in importance to the antimony deposits of China are those of Bolivia and Mexico, both of which countries, however, can produce only in time of high prices.

Mexico.—In Mexico, which has produced 20,000 tons of metallic antimony, the deposits occur principally in a belt 14 miles long lying in and between Characas and Catorce in the States of San Luis Potosí and Queretaro. They are chiefly stibnite ores but include also oxides. They are largely associated with porphyry and limestone. At Zimapan, Hidalgo, according to Lindgren and Whitehead, a large deposit of jamesonite occurs in Cretaceous limestone, and is genetically connected with intrusive monzonite and diorite porphyry.

Bolivia.—In Bolivia, which has produced antimony ore, mostly of high grade, containing 43,000 tons of metallic antimony, the deposits, mainly stibnite ore, occur chiefly in a belt 150 miles wide extending from Lake Titicaca 450 miles southward to Tupiza and Atocha, and from the Chilean boundary eastward to Potosí. They occur mainly in the departments of Potosí, Tarija and La Paz. According to Voge they occur generally in black Paleozoic shale in vertical quartz veins ranging up to 3 feet wide, but according to Miller and Singewald, they became barren at shallow depths, and some of the stibnite is auriferous and is associated with galena. The deposits, however, seem to contain a large reserve of medium or low-grade ore. Although they occur in the same region as the tin ores which frequently contain antimony minerals, the antimony veins are distinct from the tin-ore veins. Pilz regards the deposits as a differentiation product of a granite magma that according to temperature and pressure relations first formed tin and gold ore lodes, then copper, zinc-lead, and antimony-ore lodes. (*Author's abstract.*)

C. WYTHE COOKE: *Correlation of coastal terraces.*—This paper has been printed under the title *Pleistocene seashores.* (THIS JOURNAL, 20: 389–395. 1930.)

Discussed by G. R. MANSFIELD, D. WHITE, FERGUSON, LOVERING, MENDENHALL, SPENCER, RUBEY.

JAMES GILLULY, C. H. DANE, *Secretaries.*

ENTOMOLOGICAL SOCIETY

418TH MEETING (*continued*)

Remarks were made on invitation by a nonresident member, Mr. A. O. LARSON, of the Bureau of Entomology, now located in California.

Mr. LARSON said that early in the bean weevil investigation it was found that bean weevil infestations were local in their nature—that one farmer would have weevily beans at harvest time while another not far distant would have

weevil free beans of the same variety. It was found that an infestation in the field could usually be traced to a source of infestation—beans in which weevils had been allowed to breed during the summer. Quite often this source of infestation was the beans contained in bean straw stacks. Bean straw stacks held over for feed or bedding for livestock could carry weevil infestations for several years.

He also said that in sections where a concerted effort had been made to remove all sources of weevil infestation in the spring there had been a decided decrease in the amount of weevil infestation in the growing crops. He said that in the large bean growing section adjacent to Modesto, Calif., there had been a very decided decrease in the amount of bean weevil damage due to the adoption of the recommendations of the Bureau of Entomology. The weevils he discussed were the common bean weevil and the Southern cowpea weevil. (*Author's abstract.*)

Brief remarks also were made on invitation by Mr. F. J. SPRUIJT of the Bureau of Entomology, formerly located in the Pacific Northwest, but now visiting Washington from his new location on Long Island, New York. He referred very briefly to some of his recent experiences in former research work, but stated that he had barely commenced study of his present problem, and therefore was not prepared to go into it as yet with any detail. He expressed his satisfaction at opportunity of visiting Washington and examining the available literature pertaining to his work, and his pleasure at meeting the other scientific workers here.

Mr. S. A. ROHWER, on the request of the Chairman, discussed briefly some of the more recent developments pertaining to the pink bollworm work in Arizona and the Mediterranean fruit fly work in Florida.

Prior to discussing the work on the Mediterranean fruit fly, Mr. ROHWER reviewed briefly the situation regarding the pink bollworm, stating that since the last meeting of the Society guarantees satisfactory to the Secretary of Agriculture had been received from some 21 associations or corporations. These contracts provided that the guarantors would pay to the Federal Government sums which in the aggregate would equal one-half of the estimated actual and necessary losses sustained by farmers in connection with the enforced nonproduction of cotton in the noncotton zones which had been established in the State of Arizona for the crop of 1930. The contracts further provided that the guarantors would reimburse the Federal Government in event the State, through its legislature, did not, prior to December 1, 1932, appropriate and pay one-half of the actual and necessary losses. The urgent need of commencing the cleanup work at the earliest practicable date prompted the Secretary to agree to release the funds for cleanup on receipt of telegraphic advice from the guarantors that they would sign a contract acceptable to the legal advisors of the Secretary. By February 24 twenty-one guarantors had advised the Secretary that they would sign such a contract, and funds appropriated for cleanup were released on that date. The cleanup work started on the 25th and more than twelve thousand laborers are now employed in cleaning fields. In addition to this a large number of mowers and rakes are used in cutting the cotton prior to the more detailed cleanup work which is done by hand. After all the crop remnants have been removed from the fields and placed in piles they are burned.

In speaking of the Mediterranean fruit fly, Mr. ROHWER stated that a subcommittee of the House committee on appropriations, by authority conferred in a resolution passed by the House on February 10, were at the present time holding hearings in Florida to investigate the situation concerning the fruit fly and arrive at a determination as to the funds which might be appropriated for work on this pest. It will be remembered that on December

9, 1929, the President submitted an estimate requesting $15,381,000 for additional funds to carry on the eradication and other work connected with the fruit fly. Pending final consideration of the estimate, Congress by joint resolution made available $1,290,000 to carry on the work. The House Committee in reporting this estimate stated that it was not intended that any of this fund should be used for those features of the work connected with eradication. The work which had been done since January first dealt largely with inspection to determine the presence of the fly, to enforce the quarantine and to certify and supervise the movement of products under conditions imposed by the quarantine. For the work which is now being conducted it is estimated that the funds available will last until approximately the middle of April.

Mr. ROHWER also stated that information had been received from Dr. BAKER that on February 28th all living stages of the Mediterranean fruit fly in the experimental laboratory at Orlando had been destroyed. In the early phases of the work it had been necessary to maintain a stock of living material in order to get adult flies to determine what fruits and vegetables they would attack and also for the development of an insecticide for spraying purposes least injurious to the crops. The idea of having living material even for research purposes in an area where eradication was being carried on was accepted only because of the necessity of having information concerning the habits of the fly under Florida conditions and from the beginning it was the intention to use these adult flies only as long as necessary to secure information pertinent to the eradication work and later on to transfer investigations to Hawaii. The time limit set for these experiments had been March 1, and they have now been discontinued.

Mr. ROHWER further said that on the afternoon of March 4, larvae of the fruit fly were found in two sour oranges in a grove in the town of Orlando. Practically all of the fruit from this grove had already been marketed. Immediately following the discovery of the infestation, cleanup work was undertaken and other precautions to eliminate it.

In response to a question from Dr. Poos, Mr. ROHWER spoke briefly of the cleanup and removal of alternate hosts which had been carried on during the summer. At this time he emphasized that it would appear from statements included in various papers and periodicals that many of the people in the North had a very erroneous idea of the eradication work, believing that large areas of land were laid waste in connection with the campaign. He emphasized that nothing could be farther from actual facts. The work that had been done by the Department had made it possible for the growers to market their crops without material loss. With the exception of one small area in which infestation had been found on November 16, no fruit had been destroyed. In order to move their fruit to points interstate, the growers were required to keep the drops and culled fruits picked up and meet other sanitary requirements both in the groves and packing houses. In complying with these requirements the orchards were usually free from fallen fruit and to the casual observer would appear to be in unusually favorable condition. In this connection the Administration had received a large number of comments as to the favorable appearance of the groves in Florida. Furthermore the casual visitor would not notice any difference concerning crops. The requirements of the quarantine may have in individual instances imposed hardships and required the grower to change plans as to the type of vegetables or other annuals that he would plant, but such facts would not be apparent to those not thoroughly familiar with the situation. The speaker suggested that those who had knowledge of methods and facts concerning eradication coöperate and as occasion permitted correct the erroneous ideas which seem to be more or less prevalent. (*Author's abstract.*)

J. S. WADE, *Recording Secretary.*